Eversion as a Generative Metaphor for Situating Virtual Worlds in Architectural Design Education

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Abstract

Eversion can be briefly defined as the outflow of the virtual into the real. It is an emergent and open-ended process through which "life-as-we-know" is transformed into "life-as-it-could-be." In this study, we will use eversion as a generative metaphor and illustrate how virtual concepts, worlds, and processes can resonate back (or everse) into the real world. Since virtual worlds and environments are artificial constructs it is possible to have complete knowledge of their properties however we don't have the complete knowledge of their capacities yet. In this sense, creating and discussing alternative strategies, tools, and use case scenarios are crucial for the future development of virtual worlds and their integration into other fields. Therefore, based on our study of eversive processes and educational experiences, we will propose alternative strategies and scenarios for integrating virtual worlds into architectural education. Furthermore, we will introduce relevant "eversive" design studio configurations and map the necessary and optional student/coordinator competences.

Introduction

As a result of the last forty years of development in information and communication technologies, the external representational world of the today's architect has been extended to the virtual realm. This relatively new domain includes complex virtual environments, worlds,[i] tools, and applications that facilitate and support the architectural design processes (Pak, 2009). These have not only enabled architects and designers to design in a radically "new" way; they have also provided the technical solutions and material innovations to realize designs that were unthinkable before.

Today, architectural design processes entail numerous translations of real-life representations into virtual representations and virtual representations into real-life ones, and even into real buildings (Pollack, 2005; Schmal, 2001). In this context, contemporary architectural spaces emerge as a result of dynamics between the virtual and the real world(s): the inflow of the real into the virtual (immersion), and the outflow of the virtual into the real (eversion) (Novak, 1999, 2006).

Through *immersive* processes, a broad range of concepts, artifacts, and natural objects are created in and/or translated from the real world to the virtual worlds (including architecture). Consequently, these concepts, processes, and worlds transform (and get translated back into) real life through *eversion* and shape the socio-spatial environment that we are living in. In this sense, eversion becomes the most critical topic of discussion because it entails emergent and open-ended processes by which "life-as-we-know" is transformed into "life-as-it-could-be" (Langton, 1992, p. xv).

When we rethink architectural education in the light of these considerations, a number of fundamental questions inevitably arise:

- How do virtual concepts, worlds, and processes resonate back (or everse) into the real world and education?
- How can we use them in real life and design education?
- What are the opportunities for integrating these virtual concepts, worlds, and processes into architectural education?

Motivated with these questions, we will focus on the concept of eversion and explore its potential as a generative metaphor situating virtual worlds in architectural education. We will specifically address the virtual worlds, their possibility to support participatory design strategies, and their ability to facilitate knowledge production in a designerly way. In this context, we will:

- Introduce a typological analysis of virtual worlds and discuss their eversive potential.
- Reveal potential integration strategies of virtual worlds into the field of architecture and architectural education.
- Present new design studio archetypes which relate to the virtual world typologies, their eversive potentials, strategies, and case studies.
- Map the required student/coordinator competences for the new design studio archetypes
- Demonstrate a brief case study reflecting one of the design studio archetypes, integration strategies, and eversive potentials.

As a first step in the next section, by revealing our problem statement we will briefly address the current situation of the design studios in architectural education and introduce virtual realms as a possible improvement. Then we will question the relationship between virtual worlds and design education by making a typological analysis of virtual worlds. Through this analysis we will discuss the “properties” of different virtual worlds and their “capacities” for mediating and supporting architectural education.

Following the typological analysis, we will elaborate on the concepts of immersion and eversion with solid examples. In addition, we will introduce two major categories of eversion (generative and non-generative) and explain how generative eversion creates coherent novelties in a dynamic, reflective, and adaptive manner. We will then reveal a number of properties of virtual architecture that can potentially induce changes in real-life architecture.

Furthermore, reflecting on the previous sections, we will share our future perspectives for the opportunities and challenges of integrating virtual worlds into architectural design education. These perspectives will involve the discussion of possible uses of virtual strategies as tools for challenging and redefining the existing conventions with an example from our design studio.

In conclusion, we will summarize the potentials and challenges of eversion as a generative metaphor. This summary will include an outlook of what we can do and expect for the future integration of virtual worlds into design education with a focus on real-life effects.

Virtual Worlds as Reanimators for Architectural Education

The educational setting of the architectural schools is, by default, a reflective practicum (Schön, 1986), and the design studio lies at its heart. This design studio is a pedagogical setup that originates from the nineteenth century *ateliers* of the *École des Beaux-Arts* in Paris, where students were educated through "learning by doing", whereby they learn through an ongoing process of "trial-and-error" rather than merely accumulating knowledge (Wang, 2010, p. 175).

As such, students are being educated in a "conversation-like" process between the students and the educator, who is also managing the studio (Schön, 1983, p. 76, 1987, p. 56). Collaboration, rapid communication, and a broad societal relevance are characteristics of the

design studio approach (Valkenburg, 2001; Wang, 2010). However, it is difficult to claim that the design studios as practised today match these promises.

According to the American Institute of Architecture Students' (AIAS) findings on "studio culture" in 125 schools in the USA (Koch, Schwennsen, Dutton, & Smith, 2002, p. 7), a number of myths are present within most schools and design studios which lead to behaviour that is not in line with the set-up of the studio-based learning approach described above.

The extreme focus on the design product rather than the process, the marginal attention for people's needs and wishes (clients and/or society) and the overemphasis on the teacher (rather than on the student), hampers a real constructivist education in which both student and teacher are on equal footing during the design project/process[ii] (Webster, 2006, 2007).

The current emphasis on the design product, together with the emphasis on moments of evaluation, not only stimulates students to work towards a final presentation in front of a jury of "experts" or "masters", it also creates a "skewed" power hierarchy in which students have to justify their work and thoughts to the teacher (and the experts). The spatial setting of the evaluation reinforcing this hierarchical relationship is often accompanied by a discourse in which the experts show their expertise while at the same time questioning that of the student (Webster, 2006, 2007).

These observations are in stark contrast with the reality of a strong intertwinement of space, people, and time. It is in these current complex realities that architects now operate and need to find their proper place. Therefore, addressing the possible playgrounds and roles of the architect is an essential part of architectural training. Future design professionals need to be able to develop a socio-spatial cognition, and knowledge and understanding of the socio-spatial intertwinement (Loopmans, Leclercq, & Newton, 2011). However, this needs to happen through

learning, exploration, experience, and critical thinking, thereby enabling them to critically engage in building and design practices. In this sense, any learning environment suitable for architectural education needs to tackle both design and contextual knowledge.

The new opportunities created through the development of virtual worlds reveal that these virtual realms have a strong potential to extensively redefine the existing realities and relationships between clients, architects, and experts from other disciplines or the relationships between teachers and students in architectural education. In this context, virtual worlds and virtual world integrated Web 2.0 platforms can be seen as potential media for activating new types of educational approaches which cover novel research methods, theoretical knowledge from a broader range of disciplines, and facilitate collaborative knowledge construction in a network-based manner (McLoughlin & Lee, 2011).

As virtual worlds are designed and developed by people, their properties can be set to reach specific aims. For instance, a virtual world can focus on the stimulation of out-of-the box design thinking by introducing the absence of gravity or it can focus on stimulating debate and discussion between the different parties involved, thus focusing on certain communication modules. Some of these realms are specifically designed for certain aims and allow a certain degree of freedom for their use without degenerating into a "tyranny of freedom" (Schwartz, 2000, p. 85).

In order to clarify the differences between these worlds, in the next section we will focus on the wide array of possible virtual worlds, map them into a larger frame, and explore their significance for architectural education.

Typological Analysis of Virtual Worlds

Developing new typological frameworks is essential for facilitating the study of virtual worlds and understanding their possibility to support an alternative approach to the design studio as it is currently practised in most, if not all, schools of architecture.

Our review of previous studies in this field revealed that Messinger, Stroulia, and Lyons (2008) have proposed a typology of virtual worlds based on Porter's (2004) typology of virtual communities: "The five elements of the proposed typology include (1) purpose (content of interaction), (2) place (location of interaction), (3) platform (design of interaction), (4) population (participants in the interaction), and (5) profit model (return on interaction)" (p. 1). Gregory et al. (2010) have reframed and extended this discussion to the educational field and used this typology to compare the pedagogical approaches, the platforms for delivery, and the associated profit models employed by Australian higher education institutions. These studies are valuable because they provide a broader picture of the applications of virtual worlds. They also help to identify the historical development and stimulate future explorations. Moreover, they reveal the pedagogical benefits of teaching and learning in these environments.

In the context of architectural education, we think of virtual worlds in a more inclusive manner. In our field, possible virtual world platforms include Second Life and OpenSim, as well as the multi-user virtual globes such as Google Earth, augmented reality environments such as Wikitude and web-based hybrid geographic environments. Through these, users can collaborate, communicate, and create architectural spaces in a reflective manner.

Considering this variety and the fact that architectural education should be contextually embedded, we opt to organize our typological effort on two axes on which we can differentiate the relationship between the "environment" and the "content."

As humans we operate in spatial settings and our bodies are spatially anchored. However, while our body might be at a certain place at a certain time, we can also be in contact with people whose bodies are anchored somewhere else. By using virtual media we are still able to meet, discuss, and work together. The same applies for education, which happens in a certain spatial setting if defining spatial in a very broad way, from the classical classroom to the distant learning system, to the use of virtual environments. This is the first axis we define. It relates to Milgram, Takemura, Utsumi, and Kishino's (1994, p. 283) "reality-virtuality continuum", where the "strictly real-world environment clearly must be constrained by the laws of physics" while "the commonly held view of a virtual reality environment is one in which the participant observer is totally immersed in a completely synthetic world."

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On the second axis we address the content of these realms. With this purpose, we refer to the concept of the *simulacrum*, which goes back to Plato's (360 BCE) ideas on "image-making" in his famous Sophist dialogues. Plato makes a distinction between the image that is a faithful reproduction (or as good as possible) of the original and the copy that is an intentional deformation of the original. Baudrillard (1994, p. 6) takes the concept further and differentiates between four successive phases of representation of a reality. In the first phase, the image is a good reflection of the original, in the second phase the image "masks and perverts" the reality. In the following phase the image masks the absence of the basic reality, before the image becomes its own pure simulacrum in the final phase. Baudrillard (1988) argued that today we are living in a world of simulacra in which we no longer know if this world still has connections with "the

real" that has preceded it. Following Baudrillard's conceptualization of the simulacrum, one can end up being overly sceptical. Nevertheless, we are convinced that the terminology of the simulacrum is suitable to understand the wide variety of real/virtual environments that have emerged. We will therefore use the term, be it in a far more positive way, relating more to Deleuze's (1968/1994) approach of "the virtual."

Jameson (1993) used photorealism to explain this simulacrum, clarifying that a painting of a picture of reality is a copy of a copy which stands on its own. However, while in this approach the focus is on the fact that the copy bears more or less a resemblance to the original, Deleuze (1983) emphasizes that it is "the difference" that deserves attention.

As such, Deleuze argues that while the copy resembles the original, the simulacrum has a totally different end, it takes on a life of its own. This is precisely why this conceptualization is of importance and useful for our typological analysis of virtual worlds and their usefulness for education.

In our diagram, the bottom vertical axis refers to a copy of the real resembling it as much as possible. Gradually moving up the axis, the content resembles the real world less and less until finally there are unique virtual contents which are fundamentally different from the real world (e.g., hypertextual spaces).

Before revealing the future opportunities that are opened up in the last section, let us discuss some sections or "zones" of the diagram.

The Real Virtual

When we speak of the "real virtual", we refer to virtual environments that represent the real world, such as Google Earth. It is clear that they are close representations of reality, both

regarding the whole virtual environment and the architecture within it. The users are not necessarily represented as three dimensional avatars in this environment, but the users can collaborate, communicate, and create parallel architectural spaces in a reflective manner. The most extreme real virtual is the "fully simulated reality". It is a non-existent theoretical environment, first introduced in Gibson's (1984) *Neuromancer* book as a virtual reality dataspace which later inspired the movie *The Matrix* by the Wachowski Brothers (1999).

The Virtual Augmented Real

This specific category refers to the use of ubiquitous augmented information systems connected to the real-world objects. Typical examples of the virtual augmented real are the pilot support systems which draw on information from integrated virtual worlds, GPS data, and pilot's line of sight measurement (also popularly known as "terminator vision"). Pilots experience the space as a predominantly real environment where virtual information is omnipresent. Today, because of the technical complexity of these systems, architectural applications are limited to research projects. This category is closely related to the hybrid architectural spaces which combine virtual worlds and real structures.

The Real Augmented Virtual

This type includes virtual worlds where extra representational information is embedded in the virtual realm in a location based manner. Different than the virtual augmented real, information on real spaces is collected and joined in a virtual system. Wikitude is a typical example of this typology. It includes various virtual worlds which can be explored by the use of mobile devices (Wikitude, 2012) on which the real surroundings are augmented with additional interactive

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content and information, editable online by the users. Because of the relative affordability and mobility of their technical platforms these types of applications have enormous potential for user participation in planning and construction engineering which are just waiting to be realized.

The Fantastic Virtual

Fantastic virtual worlds are characterized as products of "unrestrained imagination." Multiplayer online role-playing games such as World of Warcraft or Everquest are examples of these worlds. Certain worlds that are created in the open simulator platforms can also be considered as fantastic, depending on the content and the configuration of the environments. At first glance these types of games might look less useful in the field of architectural design education. However, by changing and reconfiguring the attributes and working principles of the virtual worlds it is possible to stimulate creative thinking. For example, we can imagine and represent an environment in which people are not governed by the laws of gravity which would allow the students to test their design strategies in this completely different setting. These kinds of educational practices can be both a liberating experience and a confrontation with design thinking as it has been developed in the field so far.

Eversion as a Generative Metaphor

For architects, representational media are conceptual design domains for developing and communicating novel architectural spaces. By immersing their designs and themselves into these media and reinterpreting them, they create alternative ways of seeing (or "seeing-as" (Schön, 1983, p. 182)). In this sense, the design process can be interpreted as interplay between

architects' individual imaginary worlds and the external representational world which is also an extension of their memories.

As we have referenced in the introduction, the external representational world of today's architect is extended to the virtual realm. In this context, the actual architectural space emerges as a result of generative cyclical processes in which real-life concepts immerse into virtual space and virtual concepts everse into real life (Figure 2).

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These cycles are innovative in nature because they involve "differenciation" processes (as described by Deleuze (1968/1994, p. xiv)) which create a diverse range of alternatives and different ways of seeing. We need to see this in relation to Deleuze's ideas of the simulacra and repetition, especially when he speaks about the importance of art. In art, the act of repetition leads to the creation of the simulacra. Deleuze refers to Warhol's "serial" series[iii] as an example of this (1968/1994, p. 366). They hold within them the promise of something new.

Immersion: From Real to Virtual

Besides being a buzz-word describing human experience, immersion relates to the inflow of life-as-we-know into life-as-it-could-be. It can be considered as the "inception" to reconfigure the existing realities and challenge the accepted conventions.

Immersion involves the translation of a broad range of concepts, artifacts, and natural objects from the real world to the virtual worlds (including architecture) which requires composition and decomposition, reordering and deformation processes, or in other words, ways

of world-making (Goodman, 1978). In this sense, certain regions in Second Life illustrate how real-life architecture has "immersed" and "adapted" into a specific virtual world in a "replicative" manner, including archaic structural and building elements and conventional morphologies.

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In Second Life destinations, such as La Perla old Italy in the Furizona Region and Ancient Avaris in the Nile Region (Figure 3), the thick walls of the buildings are "replicated as" hollow boxes made out of two dimensional bits. The virtual buildings have roofs although it does not rain in Second Life and chimneys although heating is not necessary. These elements are used as symbolic tools functioning as "decor-borders" for creating simulations of non-existent touristic realities. In terms of architectural design, this type of immersive reproduction is barely interesting and inspiring.

On the other hand, immersion can be highly creative and innovative, especially when it involves the complete redefinition and recontextualization of the functionalities and programs of existent architectures. Immersion as a creative process can be a tool for reframing architectural design and encouraging new ways of knowing.

An interesting example of this type of immersion is the transformation of the abandoned coal mine in Fukuoka. This coal mine has recently been spotted by the Reddit Minecraft Subcommunity as a potential gaming environment (Reddit, 2011) and promptly "revitalized" by the community members as a virtual fortress in Minecraft to protect the users from the zombie-bots (Figure 4).

Different than the La Perla and Ancient Avaris examples, the immersion of the coal mine entails creative recontextualization rather than mere replication. In addition, the actual state of the real abandoned coal mine is also altered and amplified as an iconic event space and it became a touristic destination for nerds (Nuevos Memes, 2011). This transformation illustrates the complementary and reflective relationship between immersion and eversion. It also shows how the idea of repetition and difference can work. Although, in an embryonic state, we can imagine that this can be approached from a socially engaged perspective by starting to question the existing situation and bringing to the fore alternative visions that might be of social relevance.

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Eversion: From Virtual to Real

In contrast to immersion, eversion refers to the outflow of the virtual into the real. This concept was originally introduced as the mathematical process of "turning objects inside-out while allowing self-intersections" by Smale (1959, p. 281) and has been reframed by Novak (1999, 2006) as a complementary process to describe the possible relationship between real and virtual worlds.

Eversion can be considered as "a conceptual metaphor" for understanding and transforming a target domain in terms of a source domain, or in relation to this text, real-life architecture in terms of virtual architecture. It involves the making of a set of systematic correspondences, (or mappings (Kövecses, 2010)) between these two worlds. These correspondences are immediate and inevitable reflections of immersion and they can be creative

or reproductive in nature. In this sense, we can talk about two major categories of eversion: generative and non-generative.

Generative eversion is a process that creates coherent novelties in a dynamic, reflective, and adaptive manner. In contrast, *non-generative eversion* can be defined as limiting and replicative routines which are not capable of bringing change to the target domain. These two types of eversion can also be considered as parallel to the "divergent actualization" and "realization" of Deleuze (1968/1994, pp. 306, 263). Realization operates by limitation and resemblance whereas actualization involves differenciation (it is important to note that Deleuze's conception of "virtual" is more general than digital virtuality) (Deleuze, 1968/1994, p. 264). Actualization (or in our words generative eversion) is the process through which the full potentials of the virtual are unlocked.

The most significant property of this category of eversion is its capacity to take place in various "ways" and "at different levels". Conceptual, material, morphologic, procedural, structural, social virtualities, and metaphors can be reflected onto real life in a systematic and/or partial manner.

When thought about in the context above, specific properties of the architecture in virtual worlds that make it different from real architecture and particularly interesting as a creative discipline at the same time are:

- Hypertextual structure: Virtual architects have the opportunity to imagine and realize architectural spaces in a non-linear fashion. The inhabitants of virtual worlds can get teleported (e.g., in Second Life) instantly by passing through portals. This is a totally distinctive setup which can potentially stimulate architects to rethink the conventional structure of architectural spaces.

- High levels of interactivity/responsiveness: Our range of interactions with traditional architecture is limited and unidirectional. On the other hand, in virtual worlds it is possible to assign a variety of behaviours to the architectural elements. Experimenting with various behaviours can give way to the design of more dynamic, interactive, and exploratory environments.
- Innate information and media capacities: The architecture in virtual worlds is made of pure information. The ability to carry and transmit information is embedded in the DNA of the virtual worlds. Reflecting on such abilities, architects can rethink alternative ways of incorporating and embedding various types of information and media into real-life buildings.
- Variable emergent mathematical topologies: Virtual architectural space is mathematical and multidimensional. Various types of mathematical models offer generative formal possibilities which can alternate in time. Architects can experiment with these emergent topologies and use them as a source of inspiration.
- Alternate physics and materials: Virtual worlds provide the architects with the opportunity to explore a diverse set of physical frameworks which they can redefine. The new structure of architecture is its algorithmic framework. This is a totally new way of approaching structural systems since the laws of gravity do not necessarily apply in these environments.
- "Crowdsourcability" (lay people as designer-developers): In virtual worlds, anyone can contribute to the design and development of architectural spaces in a participatory manner. Architects do not necessarily have a privileged position in virtual worlds. In fact, since lay people are also users of the virtual spaces, architects can learn from their designs.

Future Perspectives: Integrating Virtual Worlds into Architectural Design Education

Reflecting on the concepts that we have introduced in the previous section, we will now illustrate possible ways of integrating virtual worlds into architectural design education and how an intelligent use of virtual world environments can contribute to the education of the architects of the future as critical and engaged intellectuals and designers:

- Virtual worlds as sustainable mirror media for increasing the quality of life in real worlds: Architectural schools can embrace the use of virtual worlds by collecting student works and projects in sustainable and accessible virtual environments. Student projects can be shared and experienced online with students, practicing architects, experts, and lay people to create a live and interactive debate on increasing the quality of life in real environments. These kinds of practices can also help architectural schools to establish closer relations with society. This strategy specifically relates to the "real augmented virtual" zone.
- Exploring the potentials of hybrid architectures as a combination of virtual and real worlds: Hybrid spaces are novel categories of architecture which can be considered as open fields for exploration. Integration of virtual worlds and architecture involves intense inter/transdisciplinary collaboration as cutting edge technological research and development is necessary for the design and implementation of hybrid architectures. This strategy specifically relates to "virtual augmented real" zone.
- Emergent virtual strategies as tools for challenging and redefining the existing conventions: Architectural schools can encourage the exploration of novel teaching and learning methods blended with virtual worlds and environments. The use of constructivist strategies such as

crowdsourcing and open source design can pave the way to the development of alternative design studio setups which are less top-down, more inclusive, and more student-oriented. This strategy relates to all virtual world typologies.

- Virtual parametric topologies as a source of inspiration, a medium for form finding and prototyping: As reviewed in the second section, virtual mathematical models offer tools for generating an exhaustive amount of form alternatives. Virtual worlds are potential spaces for the experiential evaluation of these emergent topologies by the architecture students and teachers. This strategy relates to the "fantastic virtual" zone.

The strategies presented above can also be considered as new design research programs for integrating virtual worlds into architectural design education using eversion as a generative metaphor as well as alternative architectural and urban design studio setups. Therefore, in the next section we will introduce three new eversive design studio archetypes that can be used as a template for the integration of virtual worlds into architectural education.

Three New Eversive Design Studio Archetypes

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The discussion of new integrative strategies for architectural education inevitably involves their use in the design studios because the studio plays a central role in design learning (Schön, 1986). It is the main strand of architectural education in which the students learn how to reflect and reflect on what they have learned through their previous educational experiences.

Therefore, in relation to the strategies and typologies that we have introduced in the previous sections, we have identified three new eversive design studio archetypes that can be used as a template for the integration of virtual worlds into architectural education:

- *Virtual Architecture/Urban Design Studio*: Focuses only on the design of virtual spaces in virtual worlds and environments and aims at the construction of an understanding of architectural design independent from the limitations of conventional architecture by the discussion of the virtual design processes, tools, and roles of the users in a designerly fashion.
    - Typology zone: The fantastic virtual
    - Example platform: OpenSim
    - Related strategies: Emergent virtual strategies as tools for challenging and redefining the existing conventions; virtual parametric topologies as a source of inspiration, a medium for form finding and prototyping
    - Example project theme: A virtual museum
- *Augmented Architecture/Urban Design Studio*: Involves the use of virtual worlds as a collaboration medium that provides contextual information and public deliberation. Aims at creating a live and interactive debate on increasing the quality of life in real environments with the contribution of practicing architects, experts, and lay people.
    - Typology zone: The real augmented virtual
    - Example platform: A Google Earth integrated web application hybrid (mash-up)
    - Related strategies: Virtual worlds as sustainable mirror media for increasing the quality of life in real worlds; Emergent virtual strategies as tools for challenging and redefining the existing conventions
    - Example project theme: Participatory regeneration of an urban neighbourhood

- *Hybrid Architectural/Urban Design Studio*: Focuses on the integration of virtual worlds and architecture. Aims at rethinking architecture as a ubiquitous technological space, an interface-bridge between real and virtual lives.
  - Typology zone: The virtual augmented real
  - Example platform(s): Real architecture and Second Life
  - Related strategies: All
  - Example project theme: An augmented and interactive urban information booth

Our previous experiences with similar types of unconventional studios and design collaborations indicate that the technological competences (together with design competences) of the students are highly important for the success of the design studios (Pak, Verbeke, & Ag-ukrikul, 2011). These types of educational setups are complex because they involve multiple layers of learning: learning design as a reflective practice as well as the practice of the reflection in action itself, and as an additional layer, learning the use of technological tools and strategies for integrative design.

Getting acquainted with virtual concepts, learning how to use the environment and processing information to be represented online are challenging tasks for some of the students, especially at the beginning of the design studio. In the long term, it is apparent that new educational modules are needed for supporting future competences of architectural design students and activating the proposed new design studios. Virtual world building, scripting, parametric design, prototyping, mapping, interactive design, advanced topological modelling and information modelling can be considered as examples of possible future educational modules for improving student competences (Table 1).

Table 1. Necessary and optional competences for future design studios integrating virtual worlds

Studios / **Competences**	**Virtual Architecture/ Urban Design Studio**	**Augmented Urban Design Studio**	**Hybrid Architectural Design Studio**
Scripting	●		●
Parametric design	○		●
Fabrication/prototyping			●
Mapping		●	
Virtual world building	●	●	●
Interactive design	●	○	●
Advanced topological modelling	●		●
Information modelling	●	●	●

● Necessary competence; ○ Optional competence

Acquiring all of these skills is not necessary for all the studios therefore the students can be given the opportunity to choose certain "tracks" to follow.

Example of an Augmented Urban Design Studio

During the fall semester of 2010, we organized a graduate urban design studio at Sint-Lucas School of Architecture for testing the potential of real virtual worlds as tools for challenging and redefining the existing conventions. In this studio we used a special web-based geographic virtual environment that was specifically developed for the representation and communication of alternative urban development projects (Pak, 2011). In brief, this environment is a Web 2.0

application hybrid which combines Semantic MediaWiki and Google Earth/Maps API (application program interface) for representing textual data, imagery, concepts maps, 3D models, and time-based information in a geolocated format.We have specially customized this environment to facilitate collaborative, open-source, and location-based analysis relating to the "augmented urban design studio" archetype (Pak et al., 2011). It was actively used between the first and eighth weeks of the design studio with a focus on the analysis of the project site and developing a preliminary design. The students worked in groups throughout this phase, sharing information and their findings with each other. After the eighth week, the students used their experiences to create a temporary installation on the project area and established a reflective communication with the inhabitants. After this phase they developed an urban design project on the same area considering all of their experiences.

During the whole studio process, the students actively used the web-based geographic virtual environment in a reflective manner and created an online inventory with 66 topics (pages) organized according to 11 themes. These topics included various analysis findings, sketches, photos, maps, studio presentations, and texts describing their experiences and thoughts on their future projects. The total size of the uploaded data was around five gigabytes. The contents of the group pages were not moderated by the tutors, but they had to include: a verbal description of group findings (linked with maps), photos of (physical) models, sketches, and the PDF version of group presentations and/or posters.

The studio also included field tours, tutor lectures, three workshops, and interactions with the theoretical component course that promotes the integration of theoretical concepts into the design process. The web-based geographic virtual environment was actively used during these activities (Figure 5, top left). For instance, during the field tours the whole travel route was

recorded by a GPS device and then joined with the student photos in a geolocated format. Similarly, during the neogeography workshop, the students made individual hand sketches reflecting their experiences of the city and layered them over a dynamic Google Map to create a map of collective knowledge (Figure 5, top right).

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For the evaluation of our design studio experiment we employed a variety of methods. These include on-site web analytics, a student attitude survey, a post-task user satisfaction questionnaire, and feedback meetings (Pak & Verbeke, 2012). As our space is limited in this publication we are going to share some of the relevant findings here.

One of the interesting observations was on the comparison of the student grades at the end of the analysis period with the total number of collaborative edits. The idea behind this comparative analysis was that there should possibly be some relation between the intensive collaborative use of the environment and group success (grades) in the analysis phase of our design studio (in week eight they were evaluated as a group, not individually).

We found that the groups who received higher grades had made relatively more collaborative edits (and vice versa) (Figure 6). It is impossible to derive a direct causality out of this finding, but the data indicates a possible correlation between collaborative edits and student performance. When combined with our design studio observations, these findings suggest that collaborative use of the proposed virtual environment as a knowledge resource may improve the performance of the student groups (i.e., “Everyday Life” group). On the other hand, after a

certain threshold (around 240 edits in this case), focusing too much on the web environment may also decrease the performance of the students (i.e., “Fragile” and “Networks” groups).

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In order to explore the students’ attitude towards the virtual environment and receive feedback we conducted an online survey. According to the results of this survey, a significant majority of the students (87%) strongly, mostly, or somewhat agreed that using the proposed virtual environment helped them to develop a better understanding of the project site (Brussels) (Figure 7).

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Overall, the design studio setup allowed for the regular monitoring of the student works, and most importantly, tracking their weekly progress which was used as the main indicator for evaluating their success. The virtual environment motivated the students to construct collaborative design diaries in a structured format which was found to be easy to evaluate by the studio coordinators and invited lecturers. Moreover, these contents were also open to other studio members and organizers, including the international audience, though the level of interaction is difficult to measure except for the number of page views.

Furthermore, the students reported that they had learned from each other by using a highly interactive virtual forum in which all ideas and comments come together, similar to crowdsourcing practices in other disciplines.

Conclusions

In this study we have explored the use of eversion as a generative metaphor for understanding virtual worlds and creating new strategies for integrating virtual worlds in architectural design education. Our study presents a reflective way of looking into the virtual worlds with a focus on their possible effects on the real world and their capacities to change it. We have illustrated how certain virtual concepts, worlds, and processes can resonate back (or everse) into the real world and education, and based on these observations we proposed alternative uses of these concepts, worlds, and processes in design and design education.

We introduced a new way of interpreting the virtual worlds by a typological analysis that visually locates different worlds according to their content and environments. Using this analysis, we have discussed the properties of these worlds in four groups: the real virtual, virtual augmented real, real augmented virtual, and fantastic virtual. This distinction was crucial for the in-depth discussion of the capacities of different types of virtual worlds that can mediate and support architectural design education.

Furthermore, we have elaborated on the concepts of immersion and eversion and illustrated how they relate to the architectural design education and virtual worlds. This discussion is strengthened by the introduction of two new categories of eversion (generative and non-generative), revealing the potential of generative eversion for creating novelties in a reflective and adaptive manner. Accordingly, we have situated the architecture of the virtual worlds as a source domain for metaphorical transfer and identified its potential properties that can change “architecture-as-we-know” into “architecture-as-it-could-be.”

Building on the body of knowledge that we presented, our own research studies, and design studio experiences at Sint-Lucas School of Architecture, we have proposed four different strategies for integrating virtual worlds into architectural education. Considering the fact that the design studio lies at the heart of architectural education, we have introduced three novel "eversive" design studio configurations that closely relate to the typology of virtual worlds and strategies that we previously identified. We have also mapped necessary and optional competences for future design studios integrating virtual worlds.

Finally, we presented our experiences with an Augmented Architecture/Urban Design Studio archetype and elaborated on its potentials.

Overall, this contribution can be seen as a step towards the revitalization of the architectural design curriculum to fit the needs of the contemporary world. For the future development of this curriculum, the proposed strategies, project themes, and platforms can be combined in different ways to create and implement novel integrated design studios (Table 2). For instance, in a specific design workshop, emergent (and generatively eversive) functionalities and behaviours of virtual spaces can be used as a resource for extending the limits of real architecture, and in this way students can challenge the existing conventions of architectural design thinking.

Table 2. The relationship between design studio archetypes, eversion potentials, and strategies

Virtual world zone (Typology)	**Eversion potentials**	**Strategies**	**New eversive design studio archetypes**

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The “fantastic virtual”	Hypertextual structure	Emergent virtual strategies as tools for challenging and redefining the existing conventions	Virtual Architecture Urban Design Studio
The “virtual augmented real”	High levels of interactivity/ responsiveness	Virtual worlds as a sustainable mirror media for increasing the quality of life in the real world	Hybrid Architectural Design Studio
The “real augmented virtual”	Innate information and media capacities	Virtual parametric topologies as a source of inspiration, a medium for form finding, and prototyping	Augmented Urban Design Studio
	Variable emergent mathematical topologies	Exploring the potentials of hybrid architectures as a combination of virtual and real worlds	
	Alternate physics and materials		
	“Crowdsourcability”		

The results of these design studies can be used to compare the strengths and weaknesses of these alternative setups. In this sense, eversive and hybrid spaces can be seen as unique and new design research programs which allow open fields for exploration through which the full

potentials of the virtual worlds are unlocked. In contrast with traditional design studio setups, these virtual world integrated programs can promote intense inter/transdisciplinary collaboration and knowledge transfer, as cutting edge technological research and development are inevitably necessary for the design and implementation of eversive spaces.

It is clear that education is more than mere training and "knowing that" (Cross, 2006, p. 21). Education is also about creating environments for stimulating students to position themselves as an engaged design professional. As such, in the near future we need more than a curriculum that is solely based on knowledge transfer.

We need to find alternative ways for encouraging students to think of their own position within the professional field and create novel ideas/concepts/solutions that are not merely grounded in the current conditions and problems and go beyond them. In this context, novel virtual worlds can be seen as highly suitable media for activating these types of educational approaches in the future. However, the complexity and inflexibility of the existing virtual and real environments (the educational institutions) are the biggest threats to the virtual world integrated educational practices. Therefore, conducting research studies on novel flexible and simpler types of virtual worlds, creating alternative use case scenarios, and introducing new pedagogical approaches are essential for developing this field further.

Notes

[i] We understand virtual worlds as "computer-generated, persistent 3D environments in which users co-exist as avatars exploring, building, interacting and communicating" (Koutsabasis, Vosinakis, Malisova, & Paparounas, 2012, p. 1). In the context of architectural education, we think of virtual worlds in a more inclusive manner. Possible virtual world platforms include Second Life (SL) and OpenSim, as well as the multi-user virtual globes such as Google Earth, augmented reality environments such as Wikitude and web-based hybrid geographic environments.
[ii] See also Rancières (1991) concept of the *Ignorant Schoolmaster*.
[iii] e.g., The paintings showing different versions of Marilyn Monroe or the Campbell's soup cans.

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